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A Low Component Count Video Data Terminal Using the DP8350 CRT Controller and the INS8080 CPU

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INTRODUCTION

The DP8350 is an I^2L – LS technology integrated circuit, designed to provide all control signals for a cathode ray tube (CRT) display system. This application note explains a system using the DP8350 and the INS8080 microprocessor. The design philosophy shows how the DP8350 interfaces to the INS8080, completing the function of a video data terminal with a minimum component count. After reading and understanding this application note the reader will realize the ease and flexibility of designing video terminals with the DP8350*. To thoroughly understand this application note the reader must be familiar with the DP8350 and the INS8080 microprocessor.

The video data terminal described is divided into the following sections, *(Figure 1)*.

The DP8350 CRT controller (CRTC).

The 8080 μP system which includes ROM, RAM, interrupt instruction port, oscillator, and control support chips.

The character generator.

The communication element.

The keyboard and baud rate select ports.

THE CRTC

The DP8350 generates all the required control and timing signals for displaying video information on the video monitor. Here is a summary of the controller's functions:

Dot clock, control, and counter outputs for the character generator.

Bidirectional RAM address refresh counter for refreshing the video RAM and allowing microprocessor loading to the internal DP8350 registers.

Direct drive horizontal and vertical sync signal outputs.

Direct cursor address location output. The cursor is internally delayed or pipelined, allowing for the access time of video RAM and the character generator ROM, *(Figure 1)*.

THE CPU

The microprocessor provides CRTC, operator, and external machine control for the system. When the CRT controller is not actively refreshing the video RAM, (i.e., during vertical retrace or blank scan lines), the microprocessor is enabled for system housekeeping, *(Figure 2)*. This method of multiplexing the RAM with the CPU and the CRTC eliminates the need for line buffers.

*The DP8350 is equivalent to the INS8276

THE CHARACTER GENERATOR

The character generator consists of 3 elements: an address latch to hold the input address to the character ROM allowing for the access time of the ROM; the character ROM that stores the ASCII character in a form for parallel to serial conversion by the shift register; the shift register converts the character ROMs parallel output to serial form. The serial output from the shift register is the true video output, modulating the video monitors electron beam which writes characters on the screen. All of the 3 elements of the character generator are combined in the DM8678, *(Figure 3)*. The DP8350 CRTC provides all the control signals for the DM8678.

THE COMMUNICATION ELEMENT

The INS8250 is the asynchronous communication element (ACE) for the data terminal. The ACE allows the CPU portion of the data terminal communication with peripherals or host computers at the correct baud rate, *(Figure 1)*. The ACE is programmed by the CPU to send and receive serial data at the standard baud rates from 110 to 4800 baud. The ACE, in conjunction with the DS1488 and DS1489 line drivers and receivers, also provides full RS232C synchronous communication if higher baud rates are desired. System communication speed must always be considered to insure the baud rate does not exceed the time required for the CPU to process a data byte. Asynchronous communication at baud rates higher than 4800 are possible by adding a line buffer.

SYSTEM INITIALIZATION

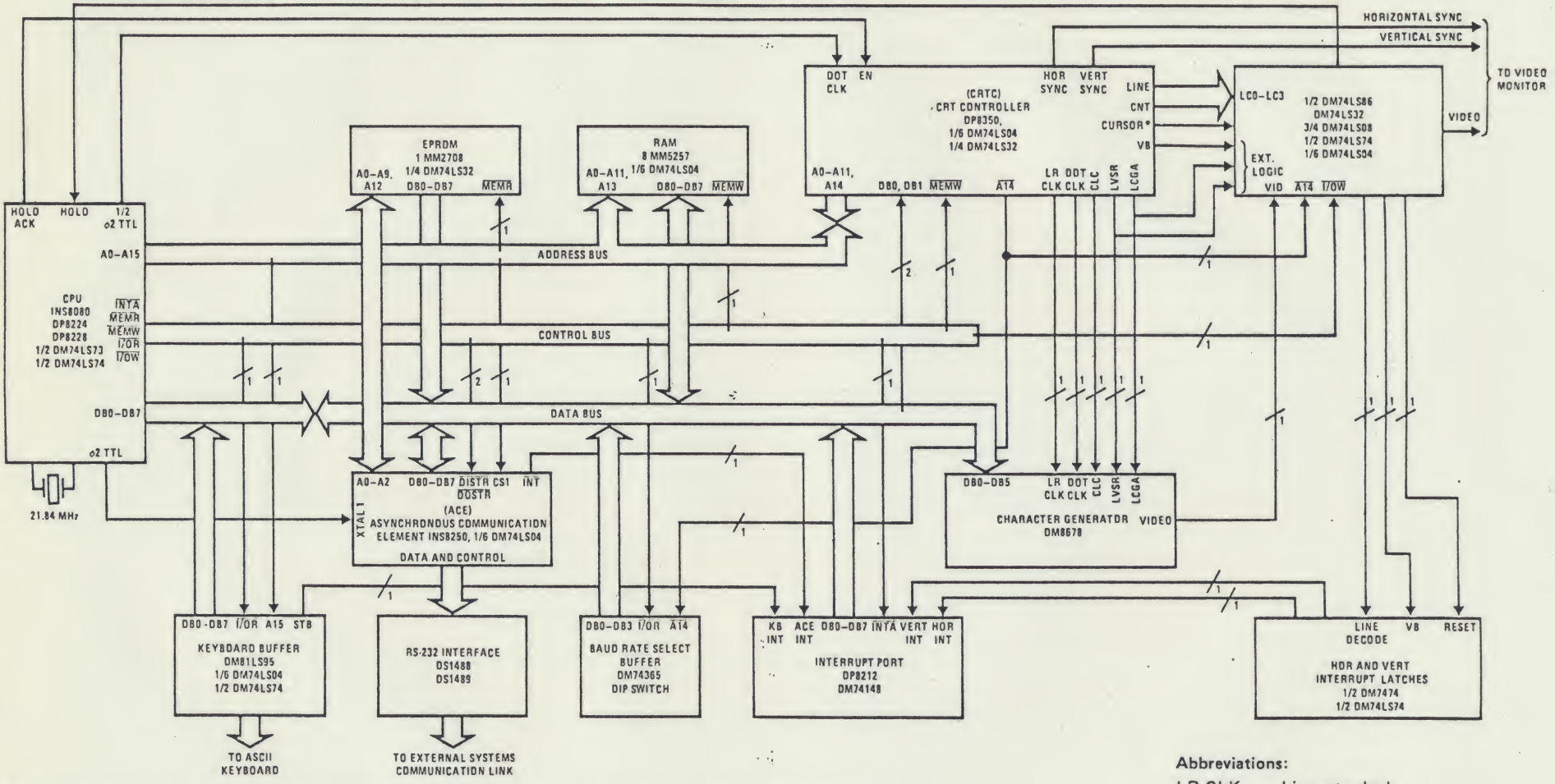
Application of the terminal's power supply resets the microprocessor, the communication element, and the CRT controller. Resetting the ACE is necessary to clear the interrupt. Resetting the CRTC is not absolutely necessary since the microprocessor loads the cursor and top of page registers in the initialization routine.

Following the reset all interrupts are disabled to avoid unwanted interrupts from the CRTC, ACE, or I/O ports. Refer to the initialization routine in the flowchart.

The stack pointer is loaded to the bottom of scratch pad RAM (3FFFH) for use as the register save pointer, *(Figure 4)*.

The entire RAM is written with ASCII spaces generating a cleared screen. After completion of the screen clear loop the CPU writes 000H to the cursor and the top of page registers in the DP8350 CRTC. The routine homes the cursor to the upper left corner of the screen. The top of page register was loaded with 000H, therefore, the video RAM is refreshed by the CRTC from that starting address to the last address on the screen of video RAM (1920 characters).

A Low Component Count Video Data Terminal Using the DP8350 CRT Controller and the INS8080 CPU



*The cursor is internally pipelined by the CRTC to allow for access time of the RAM and the character generator.

FIGURE 1. Video Data Terminal Detailed Block Diagram

Abbreviations:

LR CLK	Line rate clock
CLC	Clear line counter
LVSR	Load video shift register
LCGA	Latch character generator address
Line CNT	Line counter
EN	Enable
VID	Video
KB INT	Keyboard interrupt
VB	Vertical blanking

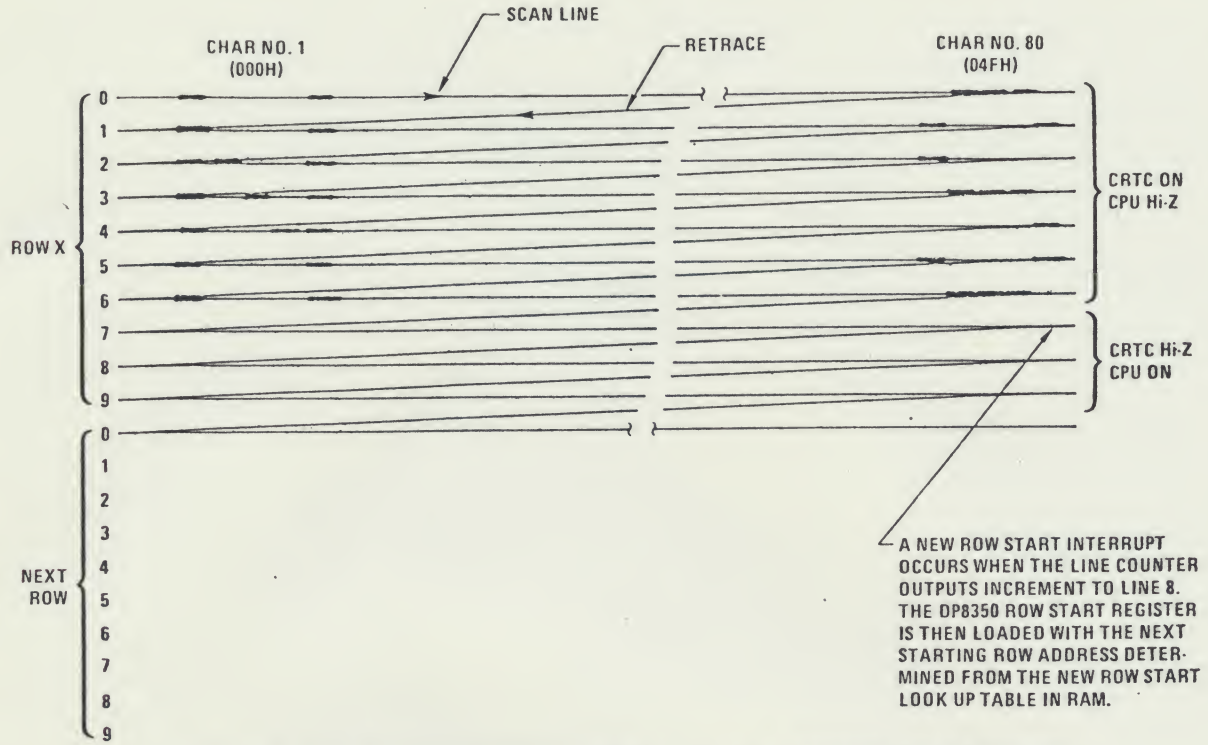


FIGURE 2. Row Start Interrupting and Multiplexing the INS8080 with the DP8350

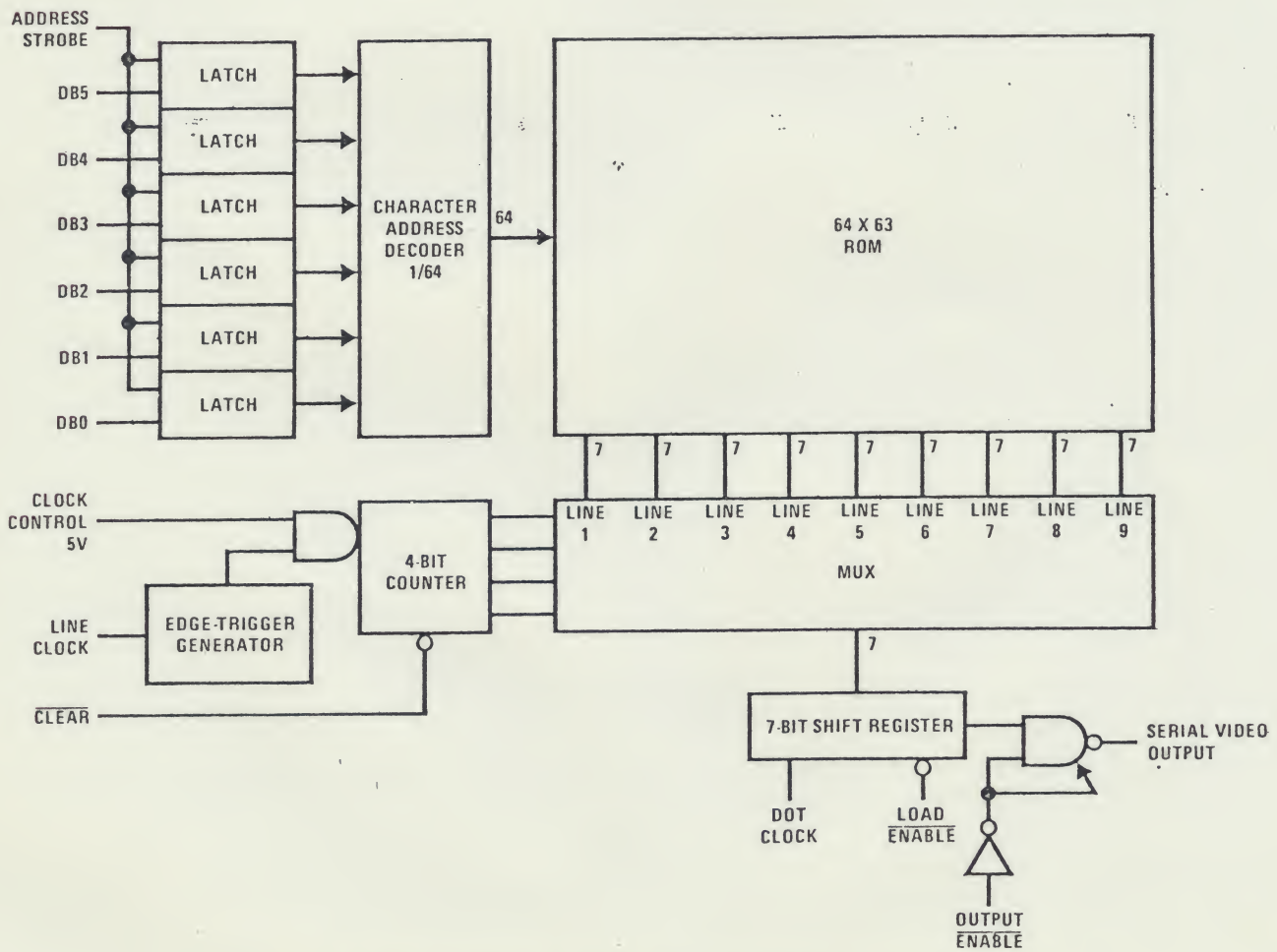


FIGURE 3. DM8678 Character Generator Block Diagram

The CPU is ready to perform the communication element (ACE) load routine. First, the baud rate divisor for the ACE must be determined. The baud rate select switch is read providing a code which corresponds to the appropriate 16-bit divisor for the ACE. This divisor determines the baud rate at which the ACE will communicate. Any additional programming requirements needed for the ACE to communicate with host computer systems could also be done at this time. The software in this system does not contain any additional programming for the ACE. There are many programming modes related to the ACE. Details of these modes are beyond the scope of this application note.

The row start look-up table, *(Figure 5)*, is loaded up by a simple algorithm that loads and adds the data for referencing a row number to that row's starting address. The reference table, *(Figure 6)*, is initialized next by direct loading. This table provides the CPU with top of page, bottom of page, next row load, cursor row, and scratch row numbers for system housekeeping.

Finally, the new row start and vertical interrupt latches are cleared, *(Figure 7)*. The register pointers are loaded and the CPU is forced in a wait loop with interrupts enabled.

NON-SEQUENTIAL ADDRESSING

The data terminal described here was designed for non-sequential starting row addressing. In many systems sequential row addressing is used. If a character row consists of 10 scan lines the RAM is addressed 10 repetitive times from 000H through 04FH, *(Figure 2)*. The next row is refreshed in the same manner from 050H to 09FH. The starting row address is sequential 000H, 050H, 0A0H—EB0H for row numbers 0H, 1H, 2H,—2FH, respectively. Non-sequential row addressing would be equivalent to 050H, 000H, 0A0H—EB0H for row numbers 1H, 0H,—2FH, respectively, *(Figure 4)*.

In conjunction with the CPU, non-sequential row addressing is quite easily accomplished with the DP8350 since this is one of the features designed into the part. Accomplishing this task basically requires the following sequence of events. Assume the CRTC has finished writing a video row in the middle of the monitor's screen. This system has a 5 x 7 character font in a 7 x 10 field, *(Figure 2)*. At the completion of the last video scan line 7 the CRTC line counters continue to count the last 3 lines. Video is not present since the character is only 7 scan lines high. The blank scan lines are 7, 8, and 9 permitting the CRTC address outputs to be TRI-STATED®, allowing the CPU to run. When the line counter outputs increment to scan line 8 an interrupt signals the CPU. The interrupt occurring is the new row start interrupt. The interrupt routine fetches the next CRTC row number from the reference table *(Figure 6)*. This number is converted to the new starting row address, explained later, and loaded to the CRTC row start register. The CPU finishes the routine by clearing the interrupt, readying itself for the next new row start interrupt. The entire routine takes 1 scan line of time, approximately 64 μs. The CRTC continues to scan the video RAM from that new starting address on for the next 7 repetitive scan lines of the next row. Many advantages become apparent using the non-sequential addressing scheme. Scrolling up or down with the cursor always on the screen may be done faster and easier from a hardware/software standpoint. Exchanging one row with another row is fast since it is not necessary to rewrite the video RAM. Row swapping is useful for higher end terminals requiring row editing functions.

ADDRESS MAP

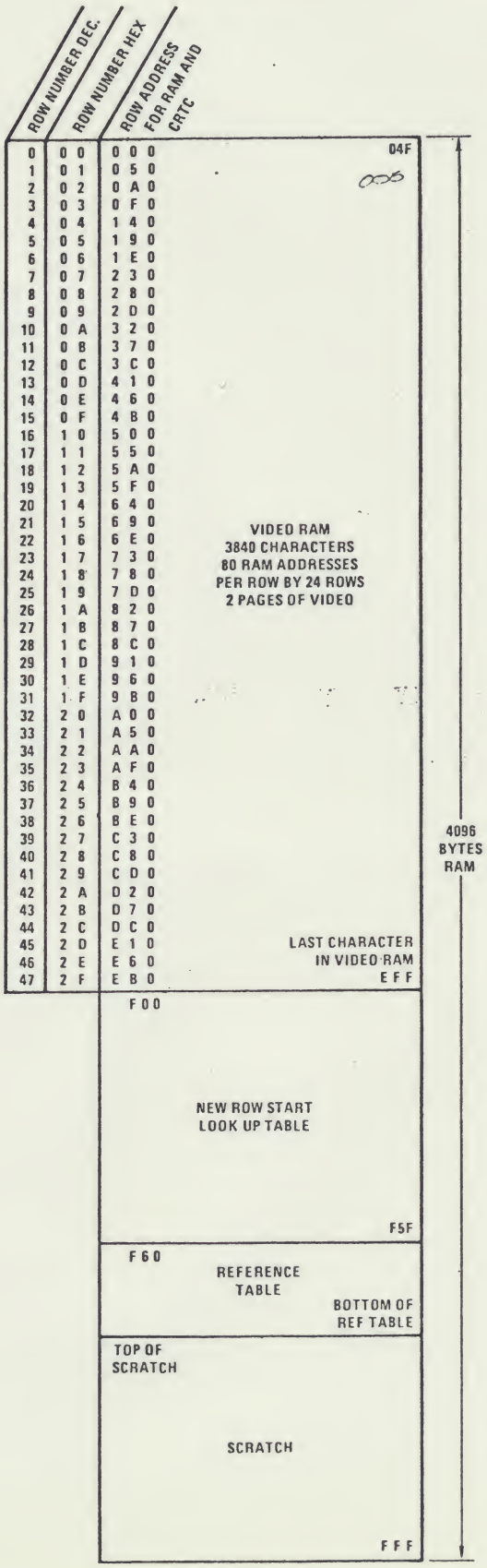


FIGURE 4. RAM Organization

MEMORY REFERENCE TABLES

Page 1

ROW NUMBER		NRS HIGH		NRS LOW	
DEC	HEX	ADDRESS	ROW DATA	ADDRESS	ROW DATA
0	0 0	3 F 0 0	3 0	3 F 3 0	0 0
1	0 1	3 F 0 1	3 0	3 F 3 1	5 0
2	0 2	3 F 0 2	3 0	3 F 3 2	A 0
3	0 3	3 F 0 3	3 0	3 F 3 3	F 0
4	0 4	3 F 0 4	3 1	3 F 3 4	4 0
5	0 5	3 F 0 5	3 1	3 F 3 5	9 0
6	0 6	3 F 0 6	3 1	3 F 3 6	E 0
7	0 7	3 F 0 7	3 2	3 F 3 7	3 0
8	0 8	3 F 0 8	3 2	3 F 3 8	8 0
9	0 9	3 F 0 9	3 2	3 F 3 9	D 0
10	0 A	3 F 0 A	3 3	3 F 3 A	2 0
11	0 B	3 F 0 B	3 3	3 F 3 B	7 0
12	0 C	3 F 0 C	3 3	3 F 3 C	C 0
13	0 D	3 F 0 D	3 4	3 F 3 D	1 0
14	0 E	3 F 0 E	3 4	3 F 3 E	6 0
15	0 F	3 F 0 F	3 4	3 F 3 F	B 0
16	1 0	3 F 1 0	3 5	3 F 4 0	0 0
17	1 1	3 F 1 1	3 5	3 F 4 1	5 0
18	1 2	3 F 1 2	3 5	3 F 4 2	A 0
19	1 3	3 F 1 3	3 5	3 F 4 3	F 0
20	1 4	3 F 1 4	3 6	3 F 4 4	4 0
21	1 5	3 F 1 5	3 6	3 F 4 5	9 0
22	1 6	3 F 1 6	3 6	3 F 4 6	E 0
23	1 7	3 F 1 7	3 7	3 F 4 7	3 0

Page 2

ROW NUMBER		NRS HIGH		NRS LOW	
DEC	HEX	ADDRESS	ROW DATA	ADDRESS	ROW DATA
24	1 8	3 F 1 8	3 7	3 F 4 8	8 0
25	1 9	3 F 1 9	3 7	3 F 4 9	D 0
26	1 A	3 F 1 A	3 8	3 F 4 A	2 0
27	1 B	3 F 1 B	3 8	3 F 4 B	7 0
28	1 C	3 F 1 C	3 8	3 F 4 C	C 0
29	1 D	3 F 1 D	3 9	3 F 4 D	1 0
30	1 E	3 F 1 E	3 9	3 F 4 E	6 0
31	1 F	3 F 1 F	3 9	3 F 4 F	B 0
32	2 0	3 F 2 0	3 A	3 F 5 0	0 0
33	2 1	3 F 2 1	3 A	3 F 5 1	5 0
34	2 2	3 F 2 2	3 A	3 F 5 2	A 0
35	2 3	3 F 2 3	3 A	3 F 5 3	F 0
36	2 4	3 F 2 4	3 B	3 F 5 4	4 0
37	2 5	3 F 2 5	3 B	3 F 5 5	9 0
38	2 6	3 F 2 6	3 B	3 F 5 6	E 0
39	2 7	3 F 2 7	3 C	3 F 5 7	3 0
40	2 8	3 F 2 8	3 C	3 F 5 8	8 0
41	2 9	3 F 2 9	3 C	3 F 5 9	D 0
42	2 A	3 F 2 A	3 D	3 F 5 A	2 0
43	2 B	3 F 2 B	3 D	3 F 5 B	7 0
44	2 C	3 F 2 C	3 D	3 F 5 C	C 0
45	2 D	3 F 2 D	3 E	3 F 5 D	1 0
46	2 E	3 F 2 E	3 E	3 F 5 E	6 0
47	2 F	3 F 2 F	3 E	3 F 5 F	B 0

FIGURE 5. New Row Start Look Up Table

FUNCTION	ADDRESS	DATA	INITIALIZED DATA
Last Row #	3F60	XY	17
8080 Row #	3F61	XY	00
First Row #	3F62	XY	00
Character #	3F63	XY	00
CRTC Row #	3F64	XY	00
Row Save #	3F65	XY	00
Temp. 1	3F66	XY	00
Temp. 2	3F67	XY	00

FIGURE 6. Reference Table

COMMAND		FUNCTION
OUT	40	Clear new row start and vertical interrupt latches
IN	80	Read keyboard
IN	40	Read baud rate select switch

FIGURE 7. Input/Output Space

DEVICE	ADDRESS*
ROM	0000 to 0FFF
RAM	3000 to 3FFF
CRTC	5000 to 5FFF
ACE	9000 to 9007

*Direct device selecting was used to minimize the system component count

FIGURE 8. CPU Addressing Space

ROW NUMBER		NRS HIGH		NRS LOW	
DEC	HEX	ADDRESS	ROW DATA	ADDRESS	ROW DATA
32	2 0	3 F 2 0	3 A	3 F 5 0	0 0

Row Start Address for Row 20H.

3XXX Selects RAM.

5XXX Selects CRTC.

FIGURE 9. Example From the New Row Start Look Up Table

ROW LOADING DETAILS

Obtaining the next starting row address for the CRT controller is accomplished by an addressing and adding scheme from the new row start look-up table. The same scheme is used to determine any needed address, given the row number.

Figure 9 shows a row number and address taken from the new row start look-up table.

The row number is loaded from the reference table in RAM to a register. The CPU determines the starting address from the row number and stores it in a 16-bit pointer register. The higher order 4 bits contain address for the RAM or the CRT controller, *(Figure 8)*.

Here are the details of how this is accomplished. Refer to the new row start interrupt in the software listing and *Figure 9*.

The CPU D-E registers are loaded to point to a row number in the reference table. The number is put in the accumulator and moved into the E register. The D-E register in this example now contains 3F20 which points to NRS HIGH ROW DATA (3A). The addressed data is moved to the accumulator and then to the H register. If it was desired to point to the CRTC then 20H would have been added to it first. The D-E register still contains 3F20H. To obtain the NRS LOW ROW DATA the E register is moved to the accumulator and 30H is added to it. Now the D-E register contains 3F50H and points to NRS LOW ROW DATA (00H). The data is loaded to the accumulator and then to the L register. The H-L registers contain 3A00H which is the starting row address for row number 20H. The method just described is used throughout the terminals program to move the cursor, load the top of page, and load the new starting row address in the CRTC.

VERTICAL INTERRUPT

The vertical interrupt occurs when the CRTC has completed refreshing a video page (1920 characters) of information. Vertical blanking identifies that condition and interrupts the CPU forcing it to the vertical interrupt routine. Refer to the vertical interrupt in the flow chart. The routine moves the first row number to the CRTC row number, updating it so the next new row start load occurs with the top of the page address or the first row of the video screen.

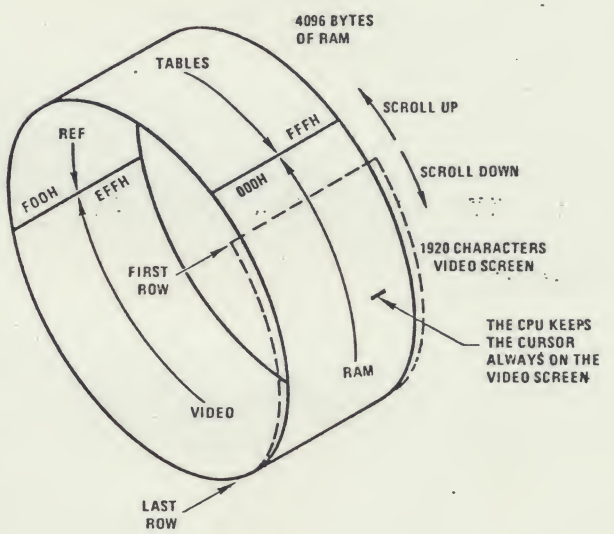
KEYBOARD INTERRUPT

The external keyboard requirements are ASCII outputs with a suitable strobe to interrupt the CPU for keyboard servicing. Refer to the keyboard interrupt in the flow chart. After the keyboard buffer is read the data byte is tested for a (CNTL E), new baud rate command. If the test fails the CPU writes the data byte to the ACE. Passing the test forces the CPU to read the baud switch and load the ACE with the new baud rate.

ACE INTERRUPT

As mentioned above, a data byte read from the keyboard that is not a baud rate command enters the accumulator. The CPU writes the data byte from the accumulator to the transmitter holding register in the ACE. The ACE proceeds to shift out the data byte, with the appropriate start and stop bits, serially from the (SOUT) output. The data is shifted to the serial input (SIN) of the ACE and loaded into the receiver holding register. When the register is full the ACE interrupts the CPU, initializating the ACE service routine. Refer to the ACE interrupt in the flow chart.

The CPU reads the receiver holding register in the ACE. Reading the ACE resets the interrupt. The data byte now resides in the accumulator. The CPU tests for a control or an escape function. The function is executed if test conditions are met. Refer to the keyboard interrupt routine in the software listing. The data byte is written to the video RAM at the cursor address which appears on the monitor screen. The cursor and character numbers are incremented as long as it is not at the end of a row. A character at the end of a row requires further testing to recognize the following situations. Is it the last row on the monitor's screen? Or is it on the maximum row of the video RAM? Essentially, the cursor is forced to stay visible on the video monitor's screen and video RAM is always kept out of scratch pad RAM, *(Figure 10)*.



The video screen is allowed to scroll only through the video RAM (000H to EFFH). The CPU keeps the video screen within these bounds by loading the new row start register with that address range only (row 00H to 2FH).

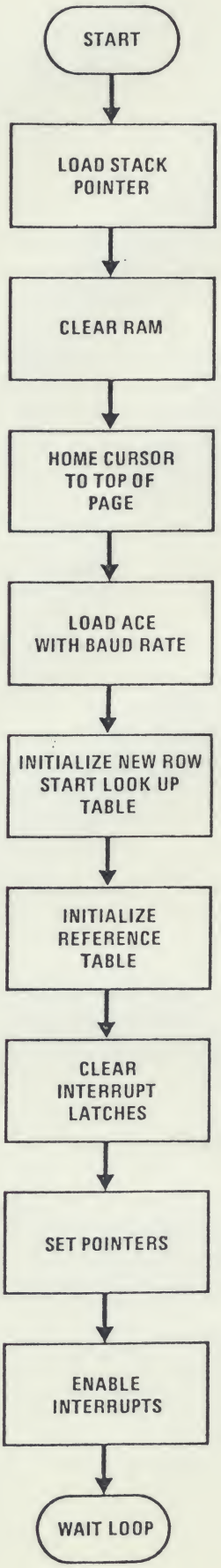
FIGURE 10. Drum Analogy for the RAM

FULL/HALF DUPLEX OPERATION

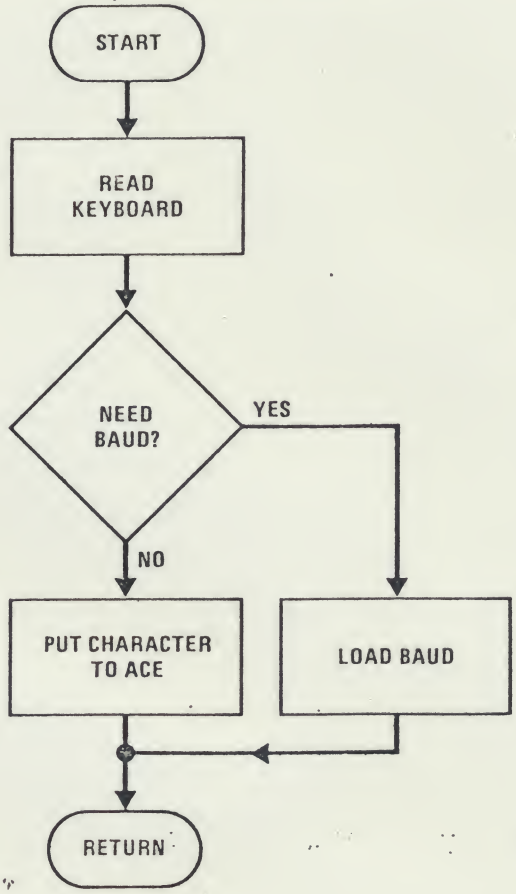
The data terminal and a host computer in the full duplex mode of operation would receive the serial information, process it, and send it back to the SIN input of ACE. Using the terminal in a stand-alone mode for testing, the serial out SOUT is tied to the serial in SIN of the ACE. In the half duplex mode a data byte is sent to the host computer at the same time it is sent to the terminal. When the data terminal is set up to communicate with a host computer the full duplex mode of operation is desirable.

DP8350/INS8080 VIDEO DATA TERMINAL BASIC SOFTWARE FLOW CHART

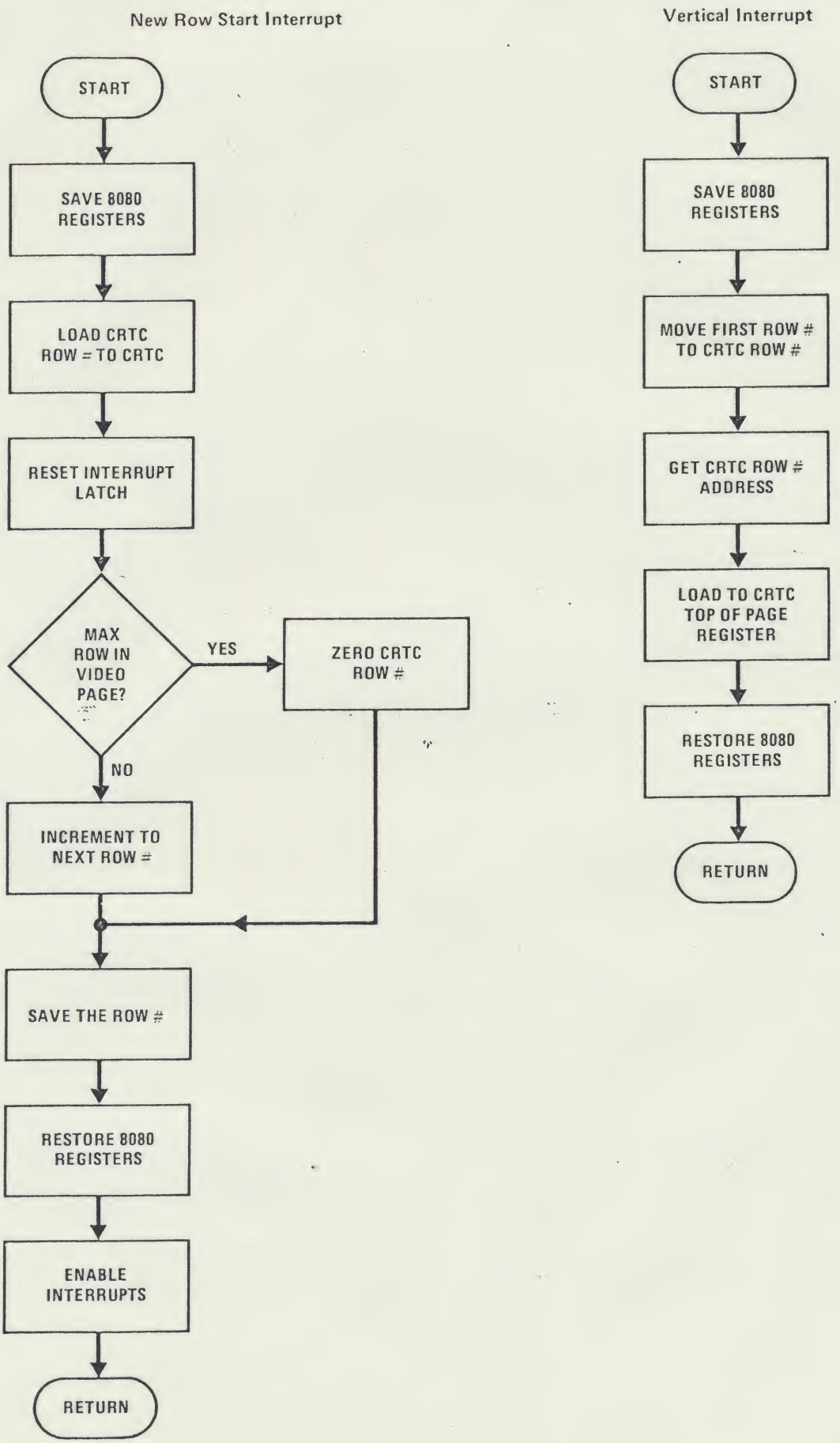
Initilization



Keyboard Interrupt

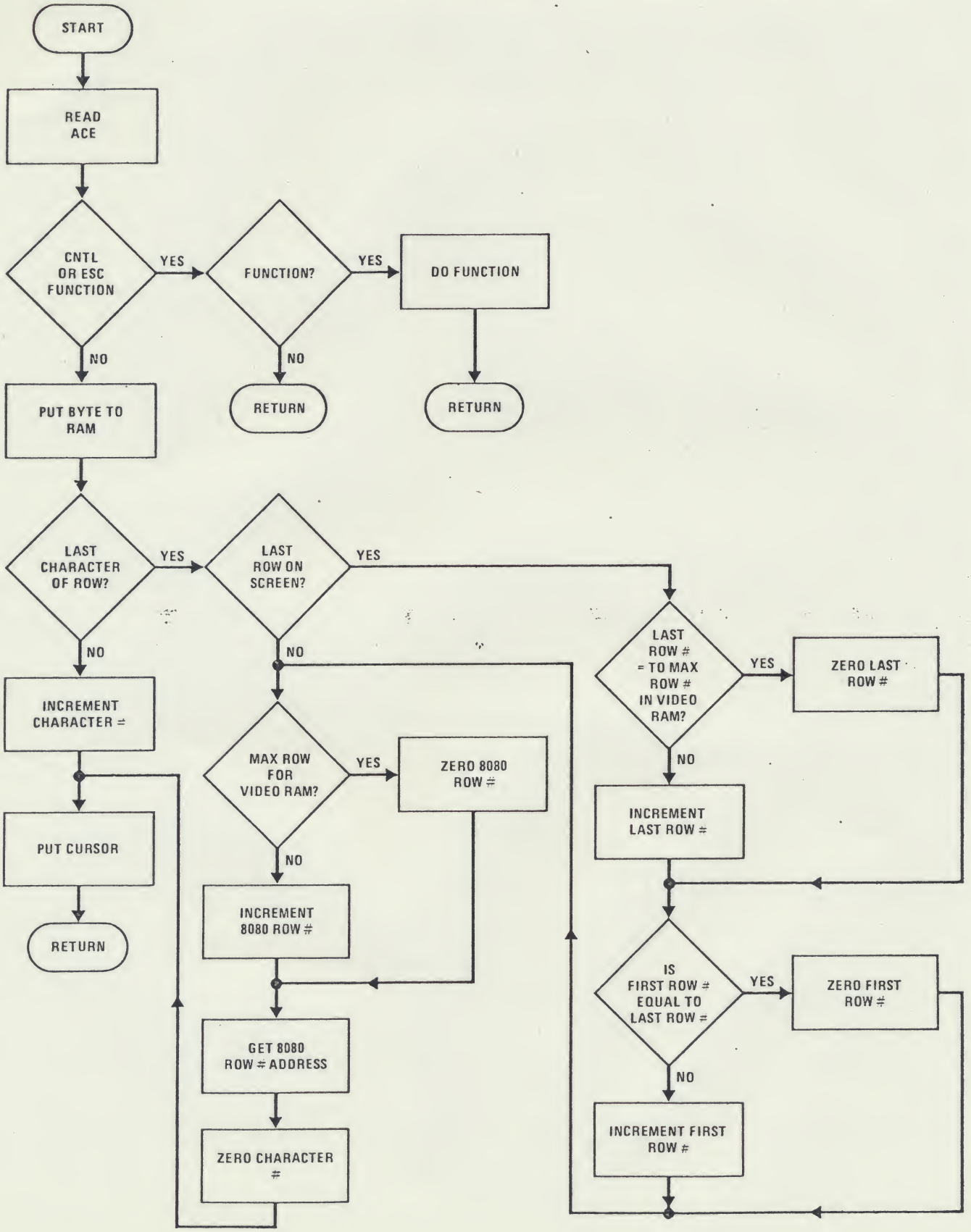


DP8350/INS8080 VIDEO DATA TERMINAL BASIC SOFTWARE FLOW CHART (Continued)



DP8350/INS8080 VIDEO DATA TERMINAL BASIC SOFTWARE FLOW CHART (Continued)

ACE Interrupt



```
                        TITLE CRTC . 8080A 02/15/78
                ;** NATIONAL SEMICONDUCTOR S
                ;   SERIES PROGRAMMABLE CRT CONTROLLER BOARD **
                ;AL BRILLIOTT-JIM TROUTNER
0060            LASTROW =               060
0061            ROWSAVE =               061
0062            FIRSTRO =               062
0063            CHARNUM =               063
0064            CRTCROW =               064
0065            ROWSAVE =               065
0066            TEMP1   =               066
0067            TEMP2   =               067
0068            IMASK   =               068
0000                    =0000
0000 F3         START   DI                      ;DISABLE INTERRUPTS
0001 31FF3F             LXI     SP,03FFF        ;LOAD STACK POINTER
0004 C33B00             JMP     INIT            ;JUMP TO INITILIZE ROUTINE
0007                    =0008
0008 C32502             JMP     NEWRO           ;NEW ROW START INTERRUPT
000B                    =0010
0010 C34A01             JMP     INTACE          ;ACE INTERUPT
0013                    =0018
0018 C33601             JMP     INTKB           ;KEYBOARD INTERUPT
001B                    =0038
0038 C34F02             JMP     VERTI           ;VERTICAL INTERUPT
003B 210030 INIT        LXI     H,03000         ;1ST RAM ADDRESS
003E 0E20               MVI     C,020           ;ASCII SPACE INTO C REG
0040 3E3F               MVI     A,03F           ;MAX RAM ADDRESS
0042 71     CLRAM       MOV     M,C             ;ASCII SPACE INTO MEM
0043 23                 INX     H               ;NEXT RAM ADDRESS
0044 BC                 CMP     H               ;MAX RAM ADDRESS?
0045 C24200             JNZ     CLRAM           ;IF NO THEN NEXT ADD
0048 0E00               MVI     C,000
004A 3E40               MVI     A,040
004C 71     CLRAM1      MOV     M,C
004D 23                 INX     H
004E BC                 CMP     H
004F C24C00             JNZ     CLRAM1
0052 CD8700             CALL    HMCUR           ;GO TO CUR HOME ROUTINE
0055 CD9300             CALL    BAUD            ;GO TO BAUD LOAD ROUTINE
                ;NEW ROW START LOOK UP TABLE GENERATION
0058 21003F             LXI     H,03F00         ;N.R.S. HIGH ADDRESS
005B 11303F             LXI     D,03F30         ;N.R.S. LOW ADDRESS
005E 010030             LXI     B,03000         ;N.R.S. ADDRESS DATA
0061 70     NRS         MOV     M,B             ;STORE TO N.R.S. DATA TABLE
0062 79                 MOV     A,C             ;N.R.S. DATA LOW TO ACC.
0063 12                 STAX    D               ;STORE TO N.R.S. DATA TABLE L
0064 C650               ADI     050             ;ACC READY FOR NEXT LOAD
0066 4F                 MOV     C,A             ;ACC TO N.R.S. DATA HIGH
0067 78                 MOV     A,B             ;N.R.S. DATA TO ACC
0068 CE00               ACI     000             ;ADD CARRY BIT TO DATA HIGH
006A 47                 MOV     B,A             ;MOVE RESULT TO N.R.S. DATA H
006B 2C                 INR     L               ;INCREMENT N.R.S. HIGH ADD
006C 1C                 INR     E               ;INCREMENT N.R.S. LOW ADD
006D 7B                 MOV     A,E             ;N.R.S. ADD LOW TO ACC
006E FE60               CPI     LASTROW         ;MAX TABLE ADDRESS
0070 C26100             JNZ     NRS             ;IF FALSE JUMP
                ;REFERENCE TABLE INITILIZE
0073 3E17               MVI     A,017           ;LAST ROW NUMBER TO ACC
0075 12                 STAX    D               ;STORE TO REFERENCE TABLE
                ;CLEAR PERIPHERAL INTERRUPT FLOPS
0076 D340               OUT     040             ;N.R.S. INTERRUPT CLEAR
0078 DB80               IN      080             ;KEYBOARD INTERRUPT CLEAR
                ;SET UP POINTERS
007A 11603F             LXI     D,03F60         ;POINT D-E TO REFERENCE TABLE
007D 210030             LXI     H,03000         ;POINT H-L TO 1ST RAM LOCATI
0080 010090             LXI     B,09000         ;POINT B-C TO ACE
                ;WAIT LOOP FOR INTERUPTS
0083 FB     BACK        EI                      ;ENABLE INTERRUPTS
0084 C38300             JMP     BACK            ;LOOP UNTIL INTERRUPTED
                ;HOME UP CURSOR
0087 210050 HMCUR       LXI     H,05000         ;POINT B-C TO CRTC
008A 3E02               MVI     A,002           ;T.O.P. REGISTER SELECT
008C 77                 MOV     M,A             ;T.O.P. LOAD
008D 3C                 INR     A               ;CURSOR REGISTER SELECT
008E 77                 MOV     M,A             ;CURSOR LOADS TO T.O.P.
008F 210030             LXI     H,03000         ;POINT H-L TO 1ST RAM ADD
0092 C9                 RET                     ;RETURN
                ;BAUD RATE SELECT
0093 D5     BAUD        PUSH    D               ;SAVE D-E REGISTERS
0094 DB40               IN      040             ;READ BAUD SELECT CODE
0096 E60F               ANI     00F             ;ZERO THE HIGH ORDER 4 BITS
0098 FE00               CPI     000
009A CAD400             JZ      B110            ;110 BAUD ROUTINE
009D FE01               CPI     001
009F CADA00             JZ      B150            ;150 BAUD ROUTINE
00A2 FE02               CPI     002
00A4 CAE000             JZ      B300            ;300 BAUD ROUTINE
00A7 FE03               CPI     003
00A9 CAE600             JZ      B600            ;600 BAUD ROUTINE
00AC FE04               CPI     004
00AE CAEC00             JZ      B1200           ;1200 BAUD ROUTINE
00B1 FE05               CPI     005
00B3 CAF200             JZ      B1800           ;1800 BAUD ROUTINE
00B6 FE06               CPI     006
00B8 CAF800             JZ      B2000           ;2000 BAUD ROUTINE
00BB FE07               CPI     007
00BD CAFE00             JZ      B2400           ;2400 BAUD ROUTINE
00C0 FE08               CPI     008
00C2 CA0401             JZ      B3600           ;3600 BAUD ROUTINE
00C5 FE09               CPI     009
00C7 CA0A01             JZ      B4800           ;4800 BAUD ROUTINE
00CA FE0A               CPI     00A
00CC CA1001             JZ      B7200           ;7200 BAUD ROUTINE
00CF FE0B               CPI     00B
00D1 CA1601             JZ      B9600           ;9600 BAUD ROUTINE
                ;BAUD RATE SET UP ROUTINES
00D4 11C305 B110        LXI     D,005C3         ;110 BAUD DIVISOR
00D7 C31C01             JMP     ACELD           ;GO TO ACE LOAD ROUTINE
00DA 11F303 B150        LXI     D,003F3         ;150 BAUD DIVISOR
00DD C31C01             JMP     ACELD
00E0 11F901 B300        LXI     D,001F9         ;300 BAUD DIVISOR
00E3 C31C01             JMP     ACELD
00E6 11FC00 B600        LXI     D,000FC         ;600 BAUD DIVISOR
00E9 C31C01             JMP     ACELD
00EC 117E00 B1200       LXI     D,0007E         ;1200 BAUD DIVISOR
00EF C31C01             JMP     ACELD
00F2 115400 B1800       LXI     D,00054         ;1800 BAUD DIVISOR
00F5 C31C01             JMP     ACELD
00F8 114C00 B2000       LXI     D,0004C         ;2000 BAUD DIVISOR
00FB C31C01             JMP     ACELD
00FE 113F00 B2400       LXI     D,0003F         ;2400 BAUD DIVISOR
0101 C31C01             JMP     ACELD
0104 112A00 B3600       LXI     D,0002A         ;3600 BAUD DIVISOR
0107 C31C01             JMP     ACELD
010A 112000 B4800       LXI     D,00020         ;4800 BAUD DIVISOR
010D C31C01             JMP     ACELD
0110 111500 B7200       LXI     D,00015         ;7200 BAUD DIVISOR
0113 C31C01             JMP     ACELD
0116 111000 B9600       LXI     D,00010         ;9600 BAUD DIVISOR
0119 C31C01             JMP     ACELD
                ;ACE LOAD ROUTINE
011C 010390 ACELD       LXI     B,09003         ;POINT B C TO ACE
011F 3E83               MVI     A,083           ;INIT BAUD LOAD - 8 BITS
0121 02                 STAX    B               ;DO INIT BAUD LOAD
0122 0E01               MVI     C,001           ;POINT TO BAUD HIGH
0124 7A                 MOV     A,D             ;GET BAUD HIGH
0125 02                 STAX    B               ;STORE BAUD HIGH TO ACE
0126 0E00               MVI     C,000           ;POINT ACE TO BAUD LOW
0128 7B                 MOV     A,E             ;GET BAUD LOW
0129 02                 STAX    B               ;STORE BAUD LOW TO ACE
012A 0E03               MVI     C,003           ;RESET DLAB TO ZERO
012C 79                 MOV     A,C             ;INIT ACE T/R
012D 02                 STAX    B               ;PUT TO ACE
012E 0E01               MVI     C,001           ;INTERRUPT ENABLE REG
0130 79                 MOV     A,C             ;SELECT RECEIVED DATA INTERR
0131 02                 STAX    B               ;LOAD IT
0132 0E00               MVI     C,000           ;RESTORE B-C ACE POINTER
0134 D1                 POP     D               ;RESTORE D-E REGISTERS
0135 C9                 RET                     ;RETURN
                ;KEYBOARD INTERRUPT ROUTINE
0136 DB80       INTKB   IN      080             ;READ KEYBOARD
0138 FB                 EI                      ;ENABLE INTERRUPTS
0139 FE05               CPI     005             ;NEED BAUD RATE? (CNTL E)
013B CA9300             JZ      BAUD            ;IF YES GO TO BAUD ROUTINE
013E FE12               CPI     012             ;INVERT NEXT CNTL R
0140 CA4803             JZ      IVERTN
0143 FE13               CPI     013             ;INVERT ROW CNTL S
0145 CA5403             JZ      IVERTR
0148 02                 STAX    B               ;STORE BYTE TO ACE
0149 C9                 RET                     ;RETURN
                ;ACE INTERUPT ROUTINE
014A 0A         INTACE  LDAX    B               ;LOAD ACE DATA BYTE TO ACC.
014B FB                 EI                      ;ENABLE INTERRUPTS
014C FE7E               CPI     07E
014E CA7001             JZ      FUNC            ;TEST FOR ESC COMAND
0151 FE7F               CPI     07F             ;TEST FOR DEL COMAND
0153 CA7001             JZ      FUNC
0156 5F                 MOV     E,A             ;SAVE CHAR IN REG E
0157 E660               ANI     060             ;MASK OUT BITS FOR CNTL TEST
0159 CA7001             JZ      FUNC            ;IF ZERO JMP TO CNTL FUNC
015C 3A683F             LDA     03F68           ;LOAD INVERT MASK
015F B3                 ORA     E               ;OR MASK AND CHAR
0160 77                 MOV     M,A             ;STORE DATA BYTE TO RAM
                ;ADVANCE CURSOR
0161 1E63       ADCUR   MVI     E,CHARNUM       ;POINT B-C TO CHAR #
0163 1A                 LDAX    D               ;LOAD CHAR # TO ACC
0164 23                 INX     H               ;NEXT CHAR LOCATION
0165 FE4F               CPI     04F             ;LAST CHAR OF ROW?
0167 CABE01             JZ      NXRO            ;IF TRUE JUMP TO NEXT ROW
016A C601               ADI     001             ;INCREMENT CHAR #
016C 12                 STAX    D               ;STORE CHAR # TO RAM REF.
016D C3B301             JMP     PCUR            ;PUT CURSOR
                ;TEST FOR FUNCTION
0170 7B         FUNC    MOV     A,E
0171 FE01               CPI     001             ;HOME AND CLEAR CNTL A (SOH)
0173 CA0000             JZ      START           ;
0176 FE0D               CPI     00D             ;CARRAGE RETURN
0178 CA6E02             JZ      CR
017B FE11               CPI     011             ;SAVE ROW # CNTL Q (DC1)
017D CA7B02             JZ      SAVRO
0180 FE0C               CPI     00C             ;ADVANCE CURSOR CNTL L (FF)
0182 CA6101             JZ      ADCUR
0185 FE02               CPI     002             ;HOME UP CNTL B (STX)
0187 CAA402             JZ      HOME
018A FE1A               CPI     01A             ;SWAP   CNTL Z (SUB)
018C CAB502             JZ      SWAP
018F FE0A               CPI     00A             ;LINEFEED
0191 CA8D02             JZ      LF
0194 FE08               CPI     008             ;BACKSPACE CNTL H (BS)
0196 CAE002             JZ      BS
0199 FE0E               CPI     00B             ;UP CURSOR CNTL K (VT)
019B CAF102             JZ      UPCUR
019E FE18               CPI     018             ;CLEAR ROW CNTL X (CAN)
01A0 CA3003             JZ      CLROW
01A3 FE07               CPI     007             ;RING BELL CNTL G (BEL)
01A5 CA4503             JZ      BELL
01A8 FE12               CPI     012             ;INVERT NEXT CNTL R (DC2)
01AA CA4803             JZ      IVERTN
01AD FE13               CPI     013             ;INVERT ROW CNTL S (DC3)
01AF CA5403             JZ      IVERTR
01B2 C9                 RET                     ;RETURN
                ;STORE CURSOR TO CRTC FROM H-L REGISTERS
01B3 7C         PCUR    MOV     A,H             ;H REG TO ACC
01B4 C620               ADI     020             ;SET H-L REG TO CRTC ADD
01B6 67                 MOV     H,A             ;H IS CRTC ADD
01B7 3603               MVI     M,003           ;CURSOR REGISTER SELECT
01B9 7C                 MOV     A,H             ;H REG SET BACK TO VIDIO RAM
01BA D620               SUI     020             ;ADDRESS
01BC 67                 MOV     H,A
01BD C9                 RET                     ;RETURN
                ;LAST ROW ON SCREEN
01BE CDDC01 NXRO        CALL    NXRO1           ;GO TO NEXT ROW SUBROUTINE
01C1 CDF301             CALL    ZCHAR           ;ZERO CHARACTER
01C4 E5     CLROW3      PUSH    H               ;SAVE H.L
01C5 1E60               MVI     E,LASTROW       ;POINT D.E TO LASTROW
01C7 1A                 LDAX    D
01C8 C601               ADI     001             ;POINT AC TO FIRST ROW OFF SC
01CA FE30               CPI     030             ;CK IF LAST ROW IN RAM
01CC CAD701             JZ      ROZERO
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(Continued on page 13)

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01CF CD8302 LOOP5   CALL    LDHL1           ;LOAD H,L WITH ADD  OF LASTRO
01D2 CD3803         CALL    CLROW2
01D5 E1             POP     H               ;RESTORE H,L
01D6 C9             RET
01D7 3E00   ROZERO  MVI     A,000           ;LOAD ROW ZERO
01D9 C3CF01         JMP     LOOP5
                    ;NEXT ROW
01DC 1E60   NXRO1   MVI     E,LASTROW       ;POINT D-E REG TO LAST ROW
01DE 1A             LDAX    D               ;PUT LAST ROW # TO ACC
01DF EB             XCHG                    ;EXCHANGE H-L WITH D-E
01E0 23             INX     H               ;H-L IS NOW AT 8080 ROW #
01E1 BE             CMP     M               ;COMPARE LAST ROW # WITH
01E2 CA0502         JZ      SCROLL          ;8080 ROW # IF TRUE SCROLL
                    ;INCREMENT 8080 ROW #
01E5 3E2F   INCRO   MVI     A,02F           ;TEST FOR MAX ROW AND
01E7 BE             CMP     M               ;JUMP TO ZERO ROW IF TRUE
01E8 CAFB01         JZ      ZROW            ;ZERO ROW
01EB 34             INR     M               ;INCREMENT THE 8080 ROW #
01EC EB             XCHG                    ;POINT H-L TO CHAR #
01ED 1E61           MVI     E,ROW8080
01EF CD8202         CALL    LDHL
01F2 C9             RET                     ;RETURN
                    ;ZERO CHARACTER
01F3 3E00   ZCHAR   MVI     A,000           ;PUT CHAR # TO ZERO
01F5 32633F         STA     03F63           ;AND STORE
01F8 C3B301         JMP     PCUR            ;GO TO PUT CURSOR ROUTINE
                    ;ZERO 8080 ROW #
01FB 3600   ZROW    MVI     M,000           ;8080 ROW # TO ZERO
01FD 2E00           MVI     L,000           ;N.R.S.  ADDRESS HIGH
01FF 56             MOV     D,M             ;N.R.S.  DATA HIGH TO D REG
0200 2E30           MVI     L,030           ;N.R.S.  ADDRESS LOW
0202 5E             MOV     E,M             ;N.R.S.  DATA LOW TO E REG
0203 EB             XCHG                    ;EXCHANGE H-L WITH D-E
0204 C9             RET                     ;RETURN
                    ;ROW SCROLL
0205 2B     SCROLL: DCX     H               ;POINT H-L TO LAST ROW#
0206 3E2F           MVI     A,02F           ;BEFORE SCRATCH TABLES.
0208 BE             CMP     M               ;TEST FOR THE LAST ROW.
0209 CA1902         JZ      ZLRO            ;JUMP TO ZERO LAST ROW IF TR
020C 34             INR     M               ;INCREMENT TO NEXT ROW.
020D 2E62   ROLO:   MVI     L,FIRSTRO       ;POINT H-L TO FIRST ROW#
020F BE             CMP     M               ;IS FIRST LOW = TO LAST ROW
0210 CA1E02         JZ      ZERO            ;JUMP TO ZERO FIRST R
0213 34             INR     M               ;INCREMENT TO NEXT ROW
0214 2E61           MVI     L,ROW8080       ;POINT H-L TO 8080 ROW
0216 C3E501         JMP     INCRO           ;GO TO INCREMENT ROW ROUTINE
0219 3600   ZLRO:   MVI     M,000           ;PUT LAST ROW# TO ZERO
021B C30D02         JMP     ROLO            ;GO TO ROUTINE FOR FIRST ROW
021E 3600   ZERO:   MVI     M,000           ;PUT FIRST ROW# TO ZERO
0220 2E61           MVI     L,ROW8080       ;POINT H-L TO 8080 ROW
0222 C3E501         JMP     INCRO           ;GO TO INCREMENT ROW ROUTINE
                    ;NEW ROW START INTERRUPT
0225 F5     NEWRO:  PUSH    PSW             ;SAVE ACC AND FLAGS
0226 E5             PUSH    H               ;SAVE H-L REG
0227 D5             PUSH    D
0228 11643F         LXI     D,03F64         ;POINT D-E TO CRTCROW #
022B 1A             LDAX    D               ;LOAD ACC WITH CRTC ROW #
022C 5F             MOV     E,A             ;N.R.S.  DATA ADD HIGH TO E
022D 1A             LDAX    D               ;ROW DATA HIGH INTO ACC
022E C620           ADI     020             ;40
0230 67             MOV     H,A             ;N.R.S.  DATA ADD HIGH INTO H
0231 7B             MOV     A,E
0232 C630           ADI     030             ;ACC TO N.R.S.  DATA LOW
0234 5F             MOV     E,A             ;N.R.S.  DATA ADD LOW TO E REG
0235 1A             LDAX    D               ;ROW DATA LOW TO ACC
0236 6F             MOV     L,A             ;N.R.S. DATA ADD LOW INTO L
0237 3601           MVI     M,001           ;STORE N.R.S.  TO CRTC
0239 D340           OUT     040             ;RESET N.R.S.  AND VERT INTER
023B 1E64           MVI     E,CRTCROW
023D 1A             LDAX    D
023E FE2F           CPI     02F             ;TEST FOR CRTC MAX ROW
0240 CA4A02         JZ      ZCRTC           ;IF TRUE ZERO ACC
0243 3C             INR     A               ;INCREMENT TO NEXT ROW
0244 12     LOOP:   STAX    D               ;STORE NEXT ROW NUMBER
0245 D1             POP     D
0246 E1             POP     H               ;RESTORE H-L REG
0247 F1             POP     PSW             ;RESTORE ACC AND FLAGS
0248 FB             EI
0249 C9             RET                     ;RETURN
                    ;ZERO CRTCROW
024A 3E00   ZCRTC.  MVI     A,000           ;ZERO ACC
024C C34402         JMP     LOOP
                    ;VERTICAL INTERRUPT
024F F5     VERTI.  PUSH    PSW             ;SAVE ACC AND FLAGS
0250 E5             PUSH    H               ;SAVE H REG
0251 D5             PUSH    D
0252 1E62           MVI     E,FIRSTRO       ;POINT D-E TO FIRST ROW #
0254 1A             LDAX    D               ;LOAD 1ST ROW # INTO ACC
0255 1E64           MVI     E,CRTCROW       ;POINT D-E TO CRTCROW #
0257 12             STAX    D               ;UPDATE CRTCROW #
0258 E63F           ANI     03F             ;REMOVE MARKER
025A 5F             MOV     E,A             ;POINT H L TO CRTC FIRST ROW
025B 1A             LDAX    D
025C C620           ADI     020             ;40
025E 67             MOV     H,A
025F 7B             MOV     A,E
0260 C630           ADI     030
0262 5F             MOV     E,A
0263 1A             LDAX    D
0264 6F             MOV     L,A
0265 3602           MVI     M,002           ;STORE TOP OF PAGE
0267 D340           OUT     040
0269 D1             POP     D
026A E1             POP     H
026B F1             POP     PSW             ;RESTORE ACC AND FLAGS
026C FB             EI
026D C9             RET                     ;RETURN

                    ;CARRAGE RETURN
026E 1E63   CR      MVI     E,CHARNUM       ;POINT D-E TO CHAR #
0270 3E00           MVI     A,000
0272 12             STAX    D
0273 1E61           MVI     E,ROW8080
0275 CD8202         CALL    LDHL
0278 C3B301         JMP     PCUR            ;CURSOR TO THE BEGINNING OF R
                    ;SAVE ROW
027B 1E61   SAVRO   MVI     E,ROW8080       ;POINT D-E TO 8080 ROW#
027D 1A             LDAX    D               ;PUT 8080 ROW # TO ACC
027E 1E65           MVI     E,ROWSAVE       ;POINT D-E TO ROW SAVE
0280 12             STAX    D               ;STORE ROW SAVE # IN REF TAB
0281 C9             RET                     ;RETURN
                    H-L ROW DATA LOAD ROUTINE
0282 1A     LDHL:   LDAX    D               ;LOAD ACC WITH D-E DATA
0283 5F     LDHL1   MOV     E,A             ;POINT D-E TO N.R.S.  DATA HI
0284 1A             LDAX    D               ;ROW # TO N.R.S.  DATA HIGH
0285 67             MOV     H,A             ;ROW # TO H REG
0286 7B             MOV     A,E             ;PUT 1ST ROW # TO ACC
0287 C630           ADI     030             ;ACC TO N.R.S.  ADD LOW
0289 5F             MOV     E,A             ;POINT D-E TO N.R.S.  DATA LOW
028A 1A             LDAX    D               ;ROW # TO N.R.S. DATA LOW
028B 6F             MOV     L,A             ;ROW # TO L REG
028C C9             RET                     ;RETURN
                    ;LINEFEED
028D CDDC01 LF:     CALL    NXRO1           ;DO NEXT ROW SUBROUTINE
0290 CDC401         CALL    CLROW3          ;OFF SCREEN CLEAR ROW ROUTINE
0293 1E61           MVI     E,ROW8080       ;MOVE REFERENCE ROW # TO H-L
0295 CD8202         CALL    LDHL            ;LOAD H-L
0298 3A633F ADDCH   LDA     03F63           ;CHAR # TO ACC
029B 85             ADD     L               ;ADD THE CHAR # TO THE
029C 6F             MOV     L,A             ;FIRST ROW ADDRESS.
029D 7C             MOV     A,H             ;IF A CARRY OCCURED ADD TO
029E CE00           ACI     000             ;THE DATA HIGH.
02A0 67             MOV     H,A             ;H-L POINTS TO LINE FED ROW
02A1 C3B301         JMP     PCUR            ;PUT CURSOR TO LINE FED ROW
                    ;HOME CURSOR TO T.O.P.
02A4 1E62   HOME:   MVI     E,FIRSTRO       ;POINT D-E TO 1ST ROW
02A6 1A             LDAX    D               ;STORE FIRSTROW TO ROW8080
02A7 1E61           MVI     E,ROW8080
02A9 12             STAX    D
02AA CD8302         CALL    LDHL1           ;MOVE REFERENCE ROW TO H-L
02AD 3E00           MVI     A,000           ;PUT CHAR # BACK
02AF 32633F         STA     03F63           ;TO ZERO
02B2 C3B301         JMP     PCUR            ;PUT CURSOR HOME
                    ;SWAP ROWS
02B5 1E65   SWAP:   MVI     E,ROWSAVE       ;POINT D-E TO ROW SAVE # AND
02B7 CD8202         CALL    LDHL            ;PUT IN H-L REG.
02BA 22663F         SHLD    03F66           ;STORE ROW SAVE # TO TEMP 1
02BD 1E61           MVI     E,ROW8080       ;POINT D-E TO 8080 ROW # AND
02BF CD8202         CALL    LDHL            ;PUT ADDRESS IN H-L REG
02C2 1E65           MVI     E,ROWSAVE       ;POINT D-E TO ROW SAVE # AND
02C4 1A             LDAX    D               ;PUT IN ACC
02C5 5F             MOV     E,A             ;8080 ROW # TO ADD HIGH
02C6 7C             MOV     A,H             ;STORE 8080 ROW # TO N.R.S.
02C7 12             STAX    D               ;DATA HIGH
02C8 7B             MOV     A,E
02C9 C630           ADI     030
02CB 5F             MOV     E,A             ;PUT 8080 ROW # TO
02CC 7D             MOV     A,L             ;N.R.S.  DATA LOW
02CD 12             STAX    D               ;8080 ROW # IS NOW IN ROW SA
02CE 2A663F         LHLD    03F66           ;PUT ROW SAVE # BACK TO H-L
02D1 1E61           MVI     E,ROW8080       ;COMENT SAME AS ABOVE
02D3 1A             LDAX    D
02D4 5F             MOV     E,A
02D5 7C             MOV     A,H
02D6 12             STAX    D
02D7 7B             MOV     A,E
02D8 C630           ADI     030
02DA 5F             MOV     E,A
02DB 7D             MOV     A,L
02DC 12             STAX    D
02DD C39802         JMP     ADDCH           ;JUMP TO ADD CHAR
                    ;BACK SPACE
02E0 1E63   BS      MVI     E,CHARNUM       ;POINT THE D-E REG TO CHAR #
02E2 1A             LDAX    D               ;AND PUT IN ACC
02E3 FE00           CPI     000             ;TEST FOR THE CHAR # =
02E5 CAEE02         JZ      UPROW           ;TO ZERO.  JUMP IF TRUE
02E8 3D             DCR     A               ;DECREMENT CHAR #
02E9 12             STAX    D               ;STORE DECREMENTED CHAR #
02EA 2B             DCX     H               ;DEC H-L FOR NEW CURSOR LOCA
02EB C3B301         JMP     PCUR            ;PUT CURSOR IN DECREMENTED LO
                    ;NEXT ROW UP
02EE 3E4F   UPROW   MVI     A,04F           ;MOVE THE CHAR #
02F0 12             STAX    D               ;TO 50H AND STORE IT
                    ;MOVE CURSOR UP
02F1 EB     UPCUR.  XCHG                    ;POINT H-L TO 8080 ROW AND D-
02F2 2E61           MVI     L,ROW8080       ;TO NEW CURSOR LOCATION
02F4 7E             MOV     A,M             ;TEST IF NEXT UP CURSOR WILL
02F5 23             INX     H               ;BE ON THE FIRST ROW
02F6 BE             CMP     M               ;IF TRUE JUMP TO
02F7 CA0803         JZ      UPSCL           ;UP SCROLL ROUTINE
02FA 2B             DCX     H               ;POINT H-L BACK TO 8080 ROW #
02FB FE00   BACK1   CPI     000             ;IF 8080 ROW # IS EQUAL TO
02FD CA1E03         JZ      RO48            ;ZERO JUMP TO ROW 48 ROUTINE
0300 35             DCR     M               ;DECREMENT 8080 ROW #
0301 EB     LOOP1   XCHG                    ;POINT H-L TO NEW CURSOR LOCA
0302 CD8202         CALL    LDHL            ;AND D-E TO 8080 ROW #  JUMP
0305 C39802         JMP     ADDCH           ;TO ADD CHARACTER ROUTINE
0308 7E     UPSCL.  MOV     A,M             ;PUT FIRST ROW # INTO ACC.
0309 FE00           CPI     000             ;TEST IF FIRST ROW # IS = TO
030B CA2403         JZ      FRO48           ;ZERO.  IF TRUE JUMP TO ROW
030E 35             DCR     M               ;48 ROUTINE
030F 2E60   LOOP2   MVI     L,LASTROW
0311 7E             MOV     A,M
0312 FE00           CPI     000
0314 CA2A03         JZ      LRO48
0317 35             DCR     M
0318 2E61   LOOP3   MVI     L,ROW8080       ;POINT H-L TO 8080 ROW #
031A 7E             MOV     A,M             ;AND LOAD TO ACC
031B C3FB02         JMP     BACK1
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524 031E 3E2F    RO48    MVI     A,02F           ;CHANGE 8080 ROW #
535 0320 77               MOV     M,A             ;TO 23D AND STORE
536 0321 C30103           JMP     LOOP1           ;JUMP TO POINTER EXCHANGE ROU
537
538 0324 3E2F    FRO48   MVI     A,02F
539 0326 77               MOV     M,A
540 0327 C30F03           JMP     LOOP2
541
542 032A 3E2F    LRO48   MVI     A,02F           ;PUT THE 1ST ROW TO
543 032C 77               MOV     M,A             ;17H
544 032D C31803           JMP     LOOP3           ;JUMP TO 8080 ROW # STORE
545
546                       ;CLEAR ROW ROUTINE
547
548 0330 CD3603 CLROW     CALL    CLROW1
549 0333 C36E02           JMP     CR
550
551 0336 1E61    CLROW1  MVI     E,ROW8080
552 0338 CD9202           CALL    LDHL            ;PUT ROW DATA IN H-L REG
553 033B 3E50    CLROW2  MVI     A,050           ;INTILIZE LOOP COUNTER
554 033D 3620    LOOP4   MVI     M,020           ;STORE ASCII SPACE IN MEM
555 033F 3D               DCR     A               ;DECREMENT LOOP COUNTER.
556 0340 C8               RZ                      ;RETURN IF ZERO BIT IS SET.
557 0341 23               INX     H               ;NEXT LOCATION
558 0342 C33D03           JMP     LOOP4           ;CLEAR NEXT LOCATION
559
560 0345 D301    BELL    OUT     001             ;RING BELL
561 0347 C9               RET
562
563 0348 AF      IVERTN  XRA     A
564 0349 1E68             MVI     E,IMASK         ;POINT D,E TO MASK
565 034B 1A               LDAX    D
566 034C 17               RAL                     ;CK BIT 8 STATUS
567 034D DA5203           JC      RESET
568 0350 3E80             MVI     A,080           ;INVERT BIT 8
569 0352 12      RESET.  STAX    D               ;STORE OUT NEW MASK
570 0353 C9               RET
571
572 0354 E5      IVERTR  PUSH    H
573 0355 1E61             MVI     E,ROW8080
574 0357 CD8202           CALL    LDHL            ;LOAD 1ST ADD. OF 8080ROW TO
575 035A 1E50             MVI     E,050           ;SET COUNTER
576 035C 7E      LOOP6:  MOV     A,M             ;GET CHAR.
577 035D 17               RAL                     ;CK BIT 8 STATUS AND INVERT
578 035E DA7003           JC      RESET1
579 0361 1F               RAR
580 0362 F680             ORI     080             ;MASK BIT 8 HIGH
581 0364 77      BACK2:  MOV     M,A             ;STORE MOD. CHAR TO MEM
582 0365 23               INX     H               ;POINT TO NEXT MEM
583 0366 7B               MOV     A,E
584 0367 FE01             CPI     001
585 0369 CA7603           JZ      DONE            ;RETURN IF COUNT = ZERO
586 036C 1D               DCR     E               ;DEC. COUNTER
587 036D C35C03           JMP     LOOP6
588
589 0370 1F      RESET1. RAR
590 0371 E67F             ANI     07F             ;RESET BIT 8
591 0373 C36403           JMP     BACK2
592
593 0376 E1      DONE.   POP     H
594 0377 C9               RET
595      0000             .END    START

A       0007    ACELD   011C    ADCUR   0161    ADDCH   0298
B       0000    B110    00D4    B1200   00EC    B150    00DA
B1800   00F2    B2000   00F8    B2400   00FE    B300    00E0
B3600   0104    B4800   010A    B600    00E6    B7200   0110
B9600   0116    BACK    0083    BACK1   02FB    BACK2   0364
BAUD    0093    BELL    0345    BS      02E0    C       0001
CHARNU  0063    CLRAM   0042    CLRAM1  004C    CLROW   0330
CLROW1  0336    CLROW2  033B    CLROW3  01C4    CR      024E
CRTCRO  0064    D       0002    DONE    0376    E       0003
FIRSTR  0062    FRO48   0324    FUNC    0170    H       0004
HMCUR   0087    HOME    02A4    IMASK   0068    INCRO   01E5
INIT    003B    INTACE  014A    INTRP   0136    IVERTN  0348
IVERTR  0354    L       0005    LASTRO  0060    LDHL    0282
LDHL1   0283    LF      028D    LOOP    0244    LOOP1   0301
LOOP2   030F    LOOP3   0318    LOOP4   033D    LOOP5   01CF
LOOP6   035C    LRO48   032A    M       0006    NEWRO   0225
NRS     0061    NXRO    01DE    NXRO1   01DC    PCUR    01B3
PSW     0006    RESET   0352    RESET1  0370    RO48    031E
ROLO    020D    ROWS80  0061    ROWSAV  0065    ROZERO  01D7
SAVRO   027B    SCROLL  0205    SP      0006    START   0000
SWAP    02B5    TEMP1   0066 *  TEMP2   0067 *  UPCUR   02F1
UPROW   02EE    UPSCL   0308    VERTI   024F    ZCHAR   01F3
ZCRTC   024A    ZERO    021E    ZLRO    0219    ZROW    01FB

 NO ERROR LINES
SOURCE CHECKSUM = 403F
OBJECT CHECKSUM = 0F51
INPUT FILE    1 CRT80A.SRC ON JIMFM
OBJECT FILE   1 CRT80A.LM ON JIMFM
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DEFINITIONS

ACE — Asynchronous communication element
CRTC — Cathode ray tube controller
Video Page — Visible screen data
Video RAM — Entire portion of RAM used only for display
First Row # — Address for top row of video page
Last Row # — Address for bottom row of video page
CRTC Row # — Address for next row load
8080 Row # — Address for cursor row
Character # — Character location in a row
XXXH are hexidecimal numbers

REFERENCES

National Semiconductor Data Sheets:

DP8350 Series Programmable CRT Controllers
INS8250 Asynchronous Communications Element
DM8678 Bipolar Character Generator
INS8080 Assembly and Reference Manuals

National Semiconductor Application Notes:

Simplify CRT Terminal Design with the DP8350, AN-198

DM8678 Bipolar Character Generator, AN-167

Data Bus and Differential Line Drivers and Receivers, AN-83

Transmission Line Characteristics, AN-108

Hardware Reference Manual BLC 80/10 Board Level Computer. National Semiconductor Microcomputer Systems Chapter 6 — System Interfacing.

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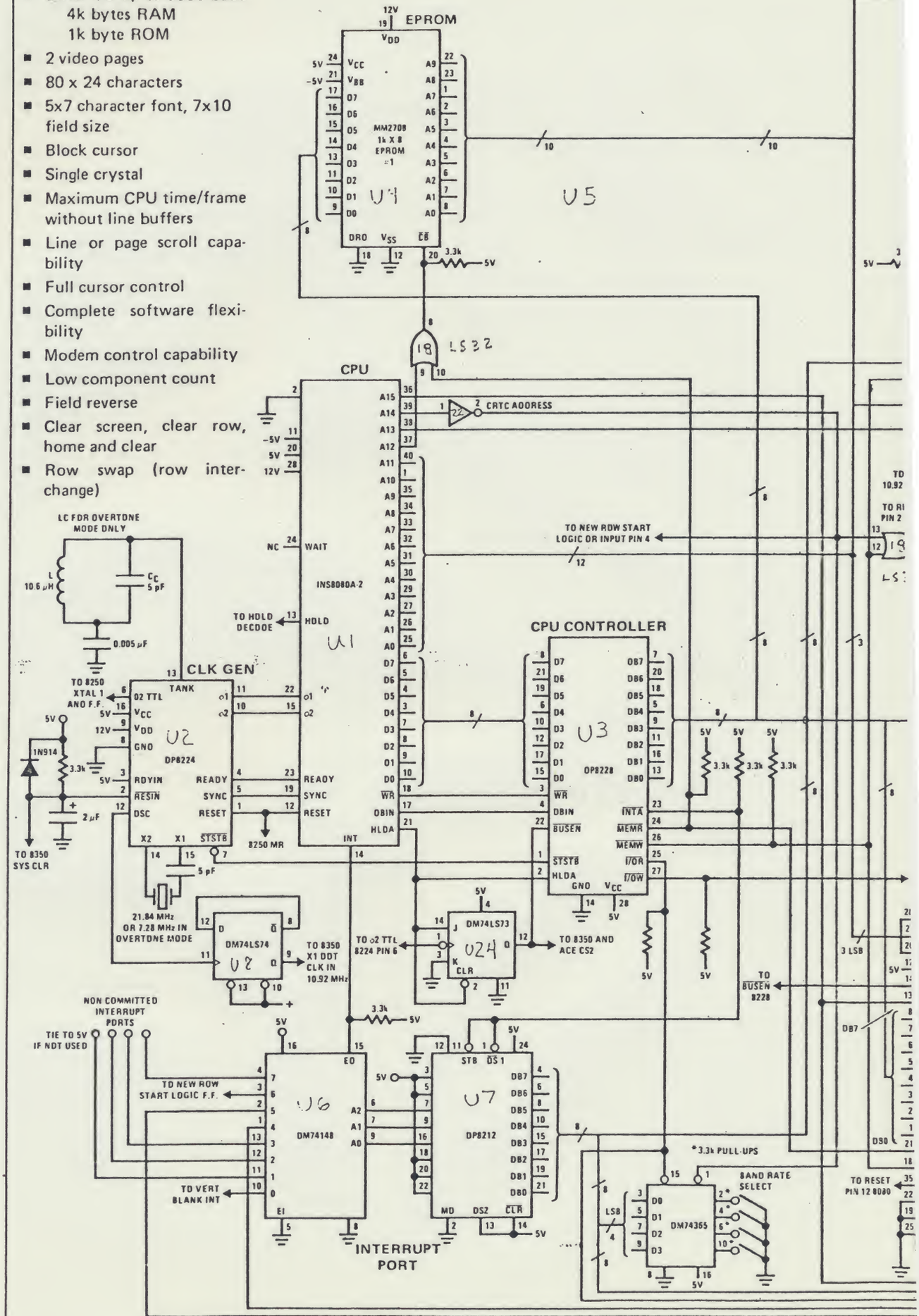
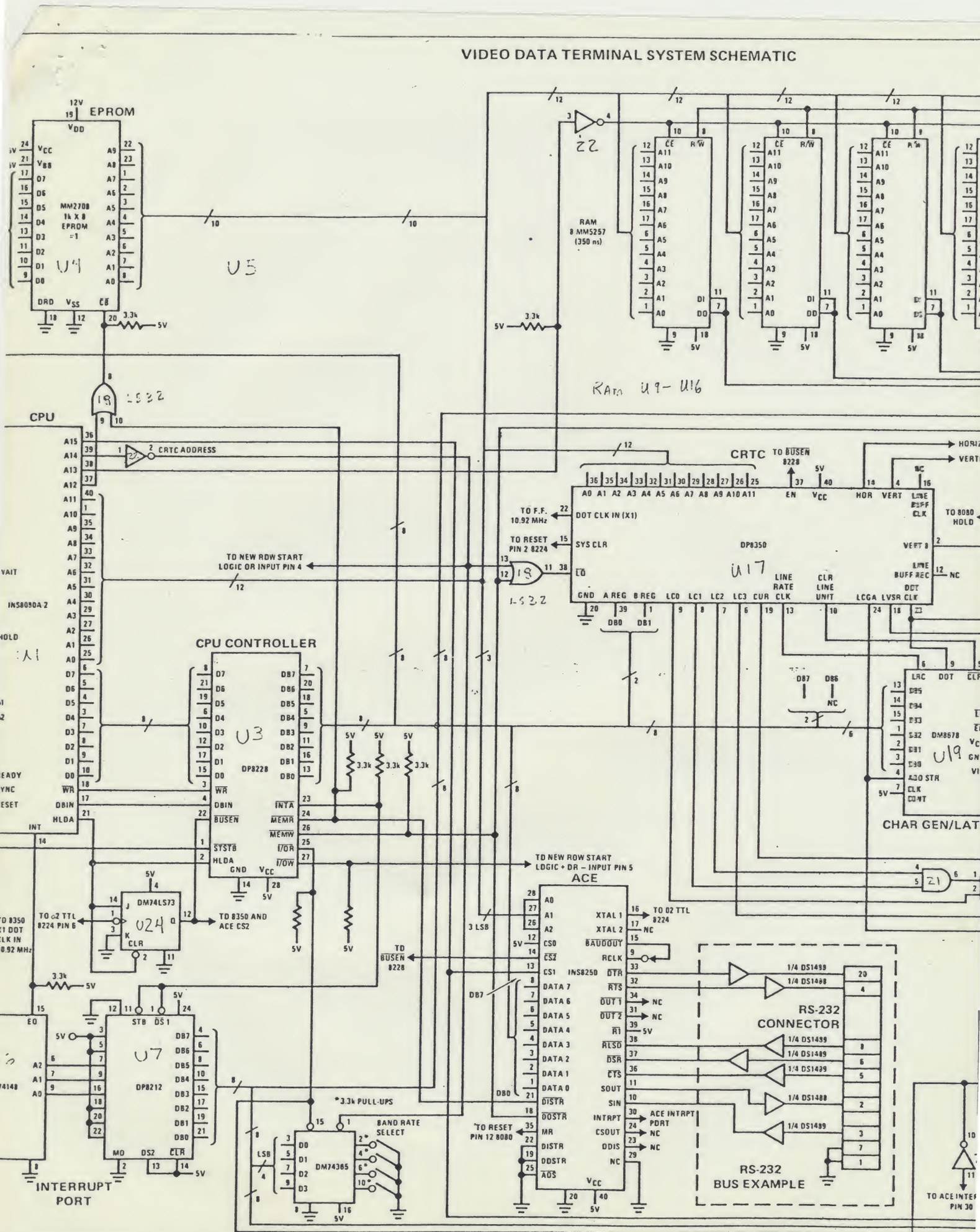
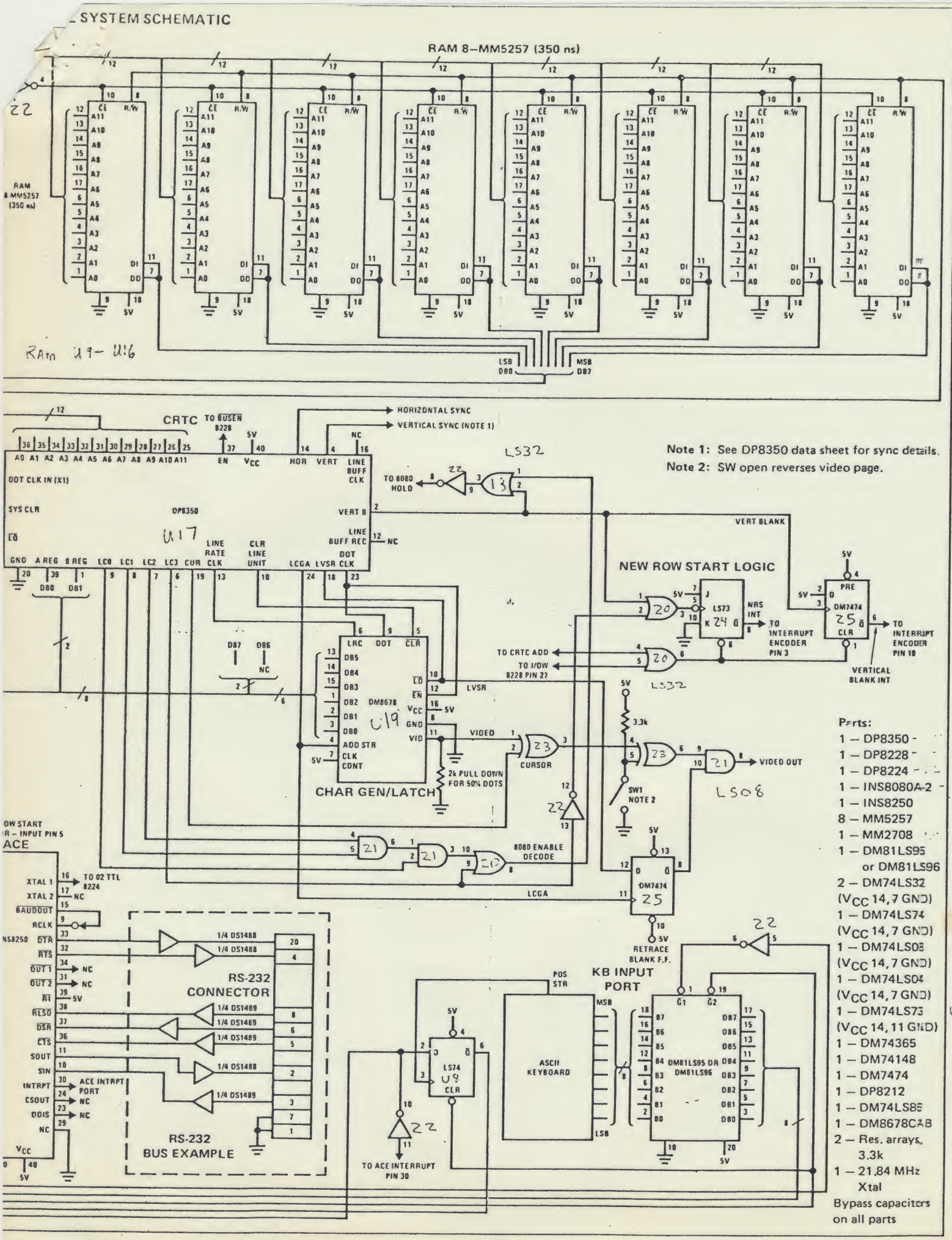
FEATURES

- Keyboard input port
- Serial I/O up to 9600 baud
  - 4k bytes RAM
  - 1k byte ROM
- 2 video pages
- 80 x 24 characters
- 5x7 character font, 7x10 field size
- Block cursor
- Single crystal
- Maximum CPU time/frame without line buffers
- Line or page scroll capability
- Full cursor control
- Complete software flexibility
- Modem control capability
- Low component count
- Field reverse
- Clear screen, clear row, home and clear
- Row swap (row interchange)




VIDEO DATA TERMINAL SYSTEM SCHEMATIC
EPROM
MM2708 1k X 8 EPROM
U4
U5
RAM 8 MM5257 (350 ns)
RAM U9 - U16
CPU
CRTC ADDRESS
CRTC
DP8350
U17
TO F.F. 10.92 MHz
DOT CLK IN (X1)
TO RESET PIN 2 8224
SYS CLR
TO NEW ROW START LOGIC OR INPUT PIN 4
TO NEW ROW START LOGIC + DR – INPUT PIN 5
CPU CONTROLLER
DP8228
U3
ACE
INS8250
RS-232 CONNECTOR
RS-232 BUS EXAMPLE
INTERRUPT PORT
DP8212
U7
DM74LS73
U24
DM74365
BAND RATE SELECT
*3.3k PULL-UPS
CHAR GEN/LATC
DM8678
U19
TO 8350 AND ACE CS2
TO 02 TTL 8224
ACE INTRPT PORT
TO RESET PIN 12 8080
TO 8080 HOLD
TO ACE INTE PIN 30



Parts:

- 1 — DP8350
- 1 — DP8228
- 1 — DP8224
- 1 — INS8080A-2
- 1 — INS8250
- 8 — MM5257
- 1 — MM2708
- 1 — DM81LS95 or DM81LS96
- 2 — DM74LS32 (V_{CC} 14, 7 GND)
- 1 — DM74LS74 (V_{CC} 14, 7 GND)
- 1 — DM74LS08 (V_{CC} 14, 7 GND)
- 1 — DM74LS04 (V_{CC} 14, 7 GND)
- 1 — DM74LS73 (V_{CC} 14, 11 GND)
- 1 — DM74365
- 1 — DM74148
- 1 — DM7474
- 1 — DP8212
- 1 — DM74LS85
- 1 — DM8678CAB
- 2 — Res. arrays, 3.3k
- 1 — 21.84 MHz Xtal

Bypass capacitors on all parts